PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in or relating to Bonding Compositions

I, RICHARD MERCER, of 20—23, Holborn, London, E.C.1, a British Subject, do hereby declare the nature of this invention (as communicated to me from abroad by Corn Products Refining Company, of 17, Battery Place, New York, United States of America, a Corporation organized under the Laws of the State of New Jersey, United States of America), and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to adhesives and methods of compounding and using the same; and the principal object of the invention is to provide an adhesive for use in the manufacture of corrugated paper, or in other similar operations, which will be cheaper and more conveniently handled than, and will have adhesive properties superior to, the silicate of soda compound which has heretofore been used exclusively, or to a very large extent, at least, in the manufacture of corrugated paper.

British Patent Specifications Nos. 466,062 and 474,583 describe the production of various bonding compositions for use in the manufacture of corrugated paper. One such composition comprises a mixture of a partially dextrinized starch with ungelatinized starch, preferably in the absence of alkali. Another example given in these specifications describes the gelatinization of starch by means of caustic soda, followed by the addition thereto of formaldehyde and the subsequent admixture thereof with ungelatinized starch.

The present invention comprises an improved process of making such compositions, according to which a heat gelatinized thin boiling starch is mixed with ungelatinized starch. By heat gelatinized thin boiling starch is to be understood starch which has been converted to the thin boiling stage by the usual method of treatment in water with an acid, and thereafter gelatinized by heat, which latter treatment produces a starch which will disperse or swell in cold water. Such a method of production possesses the advantages of reducing the number and complexity of operations to be carried out by the user and of allowing the manufacturer to exercise an increased control over the production of the bonding composition. The adhesive of the present invention consists preferably of a heat gelatinized thin boiling starch, the starch granules of which are to a very large extent ruptured and the material thereof dispersed, a raw or ungelatinized starch, that is a starch of which the granules are intact, water, a caustic alkali, such as caustic soda, and borax. The two starches are preferably supplied to the user as a dry mix. For making the adhesive paste, to be supplied to the corrugating machine, for example, the dry compound of starch is suspended in water and caustic alkali and borax added in that order. If the borax be added first it will act as a buffer and interfere with the action of the caustic alkali. The mixture thus formed is applied to the apexes of the flutings of the corrugated paper sheet as this sheet and the backing sheet pass through the machine, and the surfaces to be pasted together are subjected to heat. The heat develops the paste, as will be described, and dries and sets it. In modern machinery the sheets pass through the machine at a high rate of speed and because of the character of the corrugated sheet little pressure can be exerted against the surfaces to be pasted together particularly when a second liner is applied to the corrugated sheet. Ordinary starch paste will not serve the purpose under the exacting conditions resulting from the high speed of the operation; nor will dextrine pastes unless their water content is so reduced as to make their cost prohibitive.

The compound of the present invention can be mixed with a relatively large quantity of water so that its use is economical. Its fluidity and character are such that the paste can be spread satisfactorily on the paper by the ordinary pasting rolls.

The raw or ungelatinized starch, which, preferably, constitutes the major portion of the solids in the paste, is sent, without being pasted or gelatinized, to the point of application of the compound to the paper, by being incorporated in a fluent

vehicle consisting of a mixture of gelatinized thin boiling starch and water. When the heat is applied the raw starch granules explode or are gelatinized or pasted; and in this operation the raw starch takes up some of the water in the mixture. Some of the water is absorbed in the paper and some is evaporated. That is, a paste is formed of the heretofore ungelatinized starch at the point of application of the compound to the paper. Apparently the caustic alkali is taken up in part by the raw starch and this makes the starch more susceptible to the influence of heat and water. The caustic alkali also thickens the gelatinized starch somewhat. The borax gives the paste more tack at the point of application. The borax is essential for high speed machinery but could be dispensed with, although not to advantage, in low speed operations. For the reason that the pasting or gelatinizing of most of the starch in the compound is postponed, so to speak, until the application of the compound to the paper and the heating of the same, it is possible to use a relatively large amount of water in making up the suspension mixture of the solids which, besides facilitating the spreading of the compound on the paper, makes the compound a very economical one.

The heat gelatinized thin boiling starch used according to the invention, that is starch which has been partially converted or hydrolysed by the usual method of treatment in water with heat and an acid, and thereafter heat gelatinized, preferably by heating in a wet state on a roll or rolls. This brings about very complete gelatinization and dispersion of the starch matter. For example, a water mixture of thin boiling starch of 20 fluidity (method, essentially, of Hambden Buel, Original Communications Eighth International Congress of Applied Chemistry, Volume XIII, page 63) having a density of about 22° to 24° Baume is fed upon a doctor or spreader roll, transferred to a gelatinizing roll in contact with the doctor roll, finally scraped from the gelatinizing roll and ground. The fluidity of the starch might be varied between 10 and 60, or even higher than 60. The starch should contain a relatively large amount of moisture, enough to insure thorough gelatinization. The disadvantage of using large amounts of water is that yield is reduced. Practical densities are between 20° and 25° Baume although operation outside of this range is possible.

In actual practice an apparatus is used consisting of a main roll 9 feet long and 4 feet in diameter operated at eleven revolutions per minute, and a doctor or spreader roll 11 inches in diameter and the same length as the main roll. The gelatinizing roll is hollow and heated with steam at 48 pounds pressure per square inch. The fluidity of the starch is 20, its pH 6.5 to 6.8 and density 23.5° to 23.8° Baume. The production is 133 to 135 pounds per hour.

It is to be understood that this specification is merely illustrative. The heat gelatinization of the thin boiling starch might be effected in any suitable manner, for example, by spraying the material on rolls or by feeding it into the bight of a pair of horizontally arranged rolls as described in British Patent No. 332,680, dated December 26, 1928.

The dry compound supplied to the user consists preferably of 20 parts of gelatinized thin boiling starch as above, mixed with 80 parts of raw starch, ordinary thick boiling pearl starch, that is commercial maize starch, being preferred, although it would be possible to use thin boiling starches made by a partial acid hydrolysis (as in the case of the gelatinized starch specified above) or chlorinated starches in which the starch cells are substantially intact in distinction to being disrupted and the material dispersed, as occurs when starch, either thick boiling or thin boiling, is gelatinized.

The compound also contains, preferably, a small amount of an oily substance uniformly distributed through the starch for the purpose of preventing dust formation in the handling of the dried product. The preferred agent is one-half part of sulfonated castor oil based on weight of the dry substance compound.

The proportions between the gelatinized starch and the raw starch may be varied say as between 10% gelatinized starch to 90% raw starch and 50% gelatinized starch to 50% raw starch.

When the dry mixture above described, consisting of raw starch and pregelatinized starch, (that is, starch which has already been gelatinized before treatment with the alkali in making the paste) is to be used it is suspended in four times its weight of water, preferably at ordinary tap temperatures, and, caustic soda equal to 2—1/2% of the weight of the starch dissolved in eight times its weight of water, preferably after cooling, is added thereto. After agitating for about 15 minutes to bring about thorough mixing, 2—1 1/2% of borax, on the weight of the starch, is suspended in a small amount of water and added to the mixture. This is followed by a further thorough mixing during or before which water is added so as to bring up the total water content preferably to four and

three-quarters times the weight of the starch. The strength of the alkali is about 0.5%—0.6%, that is 0.5—0.6 parts, by weight, of alkali to 100 parts of water. At this alkalinity there will be substantially no gelatinization of the ungelatinized starch until application of heat in the corrugating machine. The compound thus formed will not separate on storage and requires no further agitation. It will not foul, mould or ferment, requires no preservative and will effectively resist the tendency to become thinned when pumped to the corrugated paper making machines.

The paste of this invention is superior to silicate of soda, for the purposes described, not only because of its lower cost, but also because the dried paste film is more elastic and less likely to break, for example, when the corrugated paper board is bent and scored in box-making.

The amount of caustic soda may be varied from 1% to 3% of the weight of the starch. The amount of the borax may be varied from 1% to 5%.

It is important that the caustic soda be properly diluted with water, so as to allow the dissipation of exothermic heat and; preferably, also it should be cooled down to room temperature, by standing, for example, for several hours, before it is added to the starch suspension; otherwise there will be danger that the starch will be thickened or partially gelatinized when the wet mixture is made and its capacity for absorbing water, at the point of application of heat impaired. The most satisfactory results are obtained by one to eight dilution, although this ratio might be varied to some extent.

The constituents of the paste may be tabulated as follows, preferred proportions by weight being given, which, it will be understood, may be considerably varied, particularly if the paste is not required for high speed operation.

Gelatinized 20 fluidity thin boiling starch	20 parts
Common thick boiling raw pearl starch (maize starch)	80 ,,
Sulfonated castor oil	½ part
Water for original suspension	400 parts
Caustic soda	2—½ ,,
Water to dissolve the caustic soda	20 ,,
Borax	2—½ ,,
Water added (including the water for suspending the borax)	55 ,,
Total	580½ parts

Generally speaking, if higher fluidity starch is used, less water will be added to the paste. If the amount of vehicle starch in the compound is reduced, less water should be added in making up the paste. The invention provides a dry, blended compound which may be prepared in a single tank by the use merely of water, caustic soda (and if desired, borax) without heating.

The method of using the compound in the manufacture of corrugated paper board is illustrated in the accompanying drawing, which is diagrammatic in character and (except for the substitution of the starch paste of the invention for silicate of soda) illustrates what has been common practice.

Referring to the drawing, *a* designates the sheet of straw board taken from roll 1 for corrugation between the heated corrugating rollers 2 and 3. Paste is applied to the tips of the corrugations from the vessel 4 by means of the rollers 5 and 6. *b* designates the first applied liner which comes from roll 7 and passes between heated rollers 8, 9, 10 and then under a pressure roller 11 into contact with the corrugating sheet *a*. The gelatinization and partial setting of the paste takes place at this point. The corrugated sheet *a* with its liner *b* passes over guide rollers 12, 13 and between feed rollers 14 and 15 to the hot plates 16, 16 . . . over which runs a belt 17, the lower turn of which is provided with the weight rollers 18. If the corrugated board be provided with a second liner, this paper sheet, designated *c*, is drawn from the roll 19 under a heating element 20 and then passes over a guide roller 21 into contact with the under surface of the corrugated sheet *a*, the tips of the corrugations of which have been coated with paste from vessel 22 by rollers 23, 24. The pasting and setting of the adhesive must take place in the bonding of *c* to *a* with a minimum amount of pressure in order to avoid crushing the flutings of the corrugated sheet. The hot plates and the rolls referred to as heated are hollow and are heated with steam at pressures from 80 to 125 pounds per square inch. The paper is run through the machine at the rate of 150 to 300 feet per minute. The higher speeds require higher temperatures.

In accordance with the present invention the potentially adhesive compound used for securing together the paper sheets making up the corrugated paper board is sufficiently thin and fluent to flow readily through the piping and to spread smoothly and evenly on the paper. This is due to the fact that the vehicle consists of starch which has been made thin boiling and has also been gelatinized, so it is in a high state of dispersion; and to the further fact that the raw starch, intended to be gelatinized by heat in the corrugated paper

making machine, is in a substantially completely ungelatinized state until the heat is applied to it at that place. In sufficient quantities or at sufficiently high temperatures, caustic alkalies bring about partial or complete gelatinization of the starch, dependent upon the intensity of the treatment. According to the present invention, however, such a small amount of alkali is used, with no heating, that no appreciable gelatinization of the raw starch takes place. The alkali does not become effective as a gelatinizing agent until heat is applied after the adhesive has been spread on the paper. The thinness of the compound, before heat is applied in the machine, is due, therefore, to two factors: the fluency of the vehicle and the ungelatinized character of the starch carried thereby. The application of heat causes the ungelatinized starch to absorb water and become instantaneously very viscous. When the paste has set the bond is very strong and tough and the paper hard and stiff, particularly if, as is preferred, raw maize starch is used as the ungelatinized or potentially adhesive element of the compound.

There is another advantage in having the starch which is to be pasted in the corrugating machine as completely ungelatinized as possible until application of heat to the adhesive film. If this starch be partially gelatinized or swelled in making the compound, which will occur if too much alkali is used, or too high temperatures in the preparation of the mix, the paste will tend to break down and lose some of its viscosity when pumped from the mixing tank to the machines where it is used and this makes it necessary to make a larger amount of the compound. The compound of the present invention may be made by the paste maker in the factory where the corrugated paper board is being manufactured by simple mixing operations requiring very little skill or judgment; the operations requiring a high degree of technical ability, namely, the conversion of the starch to the thin boiling stage and the gelatinization of the thin boiling starch having been performed by the manufacturer of the vehicle starch, which in a dry mixture with the ungelatinized starch, goes to the paste maker as a single product.

While any starch might be used for the ungelatinized starch ingredient of the paste, it is preferred to use maize starch, as indicated, because the maize starch paste gives a somewhat stiffer corrugated paper board.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed (as communicated to me from abroad), I declare that what I claim is:—

1. A process of making a compound to be used in the production of an adhesive paste for bonding purposes in which starch is treated to convert it to the thin boiling stage and to heat gelatinize it and is then mixed with ungelatinized starch.

2. A process according to Claim 1 in which the relative proportions of the starch ingredients are substantially 10 to 50 parts heat gelatinized starch and 90 to 50 parts ungelatinized starch.

3. A process according to Claim 1 or 2 in which the heat gelatinized thin boiling starch and the ungelatinized starch are mixed together in a dry state.

4. Process according to Claim 1, 2 or 3 in which the starch is converted to a thin boiling stage and thereafter gelatinized by subjecting it with water and in a thin film to contact with a heated surface.

5. Process according to Claim 1, 2, 3 or 4 in which water and a caustic alkali are added to the mixture of heat gelatinized thin boiling and ungelatinized starches, the caustic alkali being present in the adhesive mixture in an amount insufficient to gelatinize the ungelatinized starch at ordinary temperatures, for example, 0.5% —0.6% by weight of the water present.

6. Process according to Claim 1, 2, 3, 4 or 5 in which borax is added after the addition of the water and caustic alkali.

7. Process of bonding with the adhesive product of Claim 5 or 6 in which the adhesive is spread on one or both of the surfaces to be bonded, the surfaces brought together and then subjected to heat to paste the ungelatinized starch and cause the adhesive to set.

8. Process of bonding a liner to corrugated paper sheet with the adhesive product of Claim 5 or 6 in which the adhesive is applied to the tips of the corrugations, the liner is brought into contact with the adhesive coated tips, and the adhesive then heated to paste the ungelatinized starch and cause the adhesive to set.

9. Compound for forming an adhesive paste consisting of a dry mixture of ungelatinized starch and, intimately blended therewith, heat gelatinized thin boiling starch to provide a vehicle for the ungelatinized starch when the compound is mixed with water, the heat gelatinized thin boiling starch preferably having a fluidity of about 20.

10. The dry bonding mixture substantially as described.

11. The adhesive compound substantially as described.

Dated this 23rd day of March, 1939.

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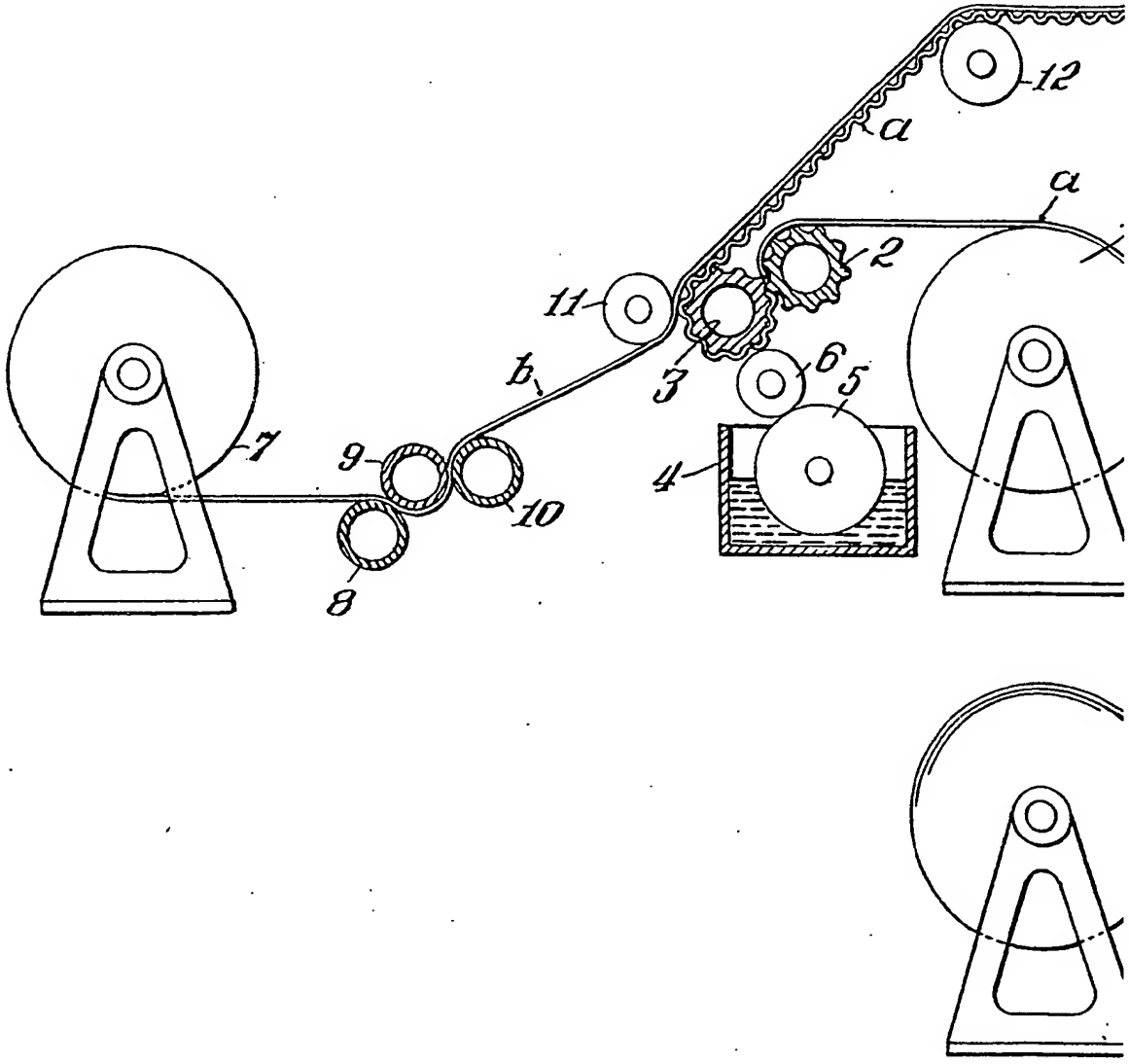

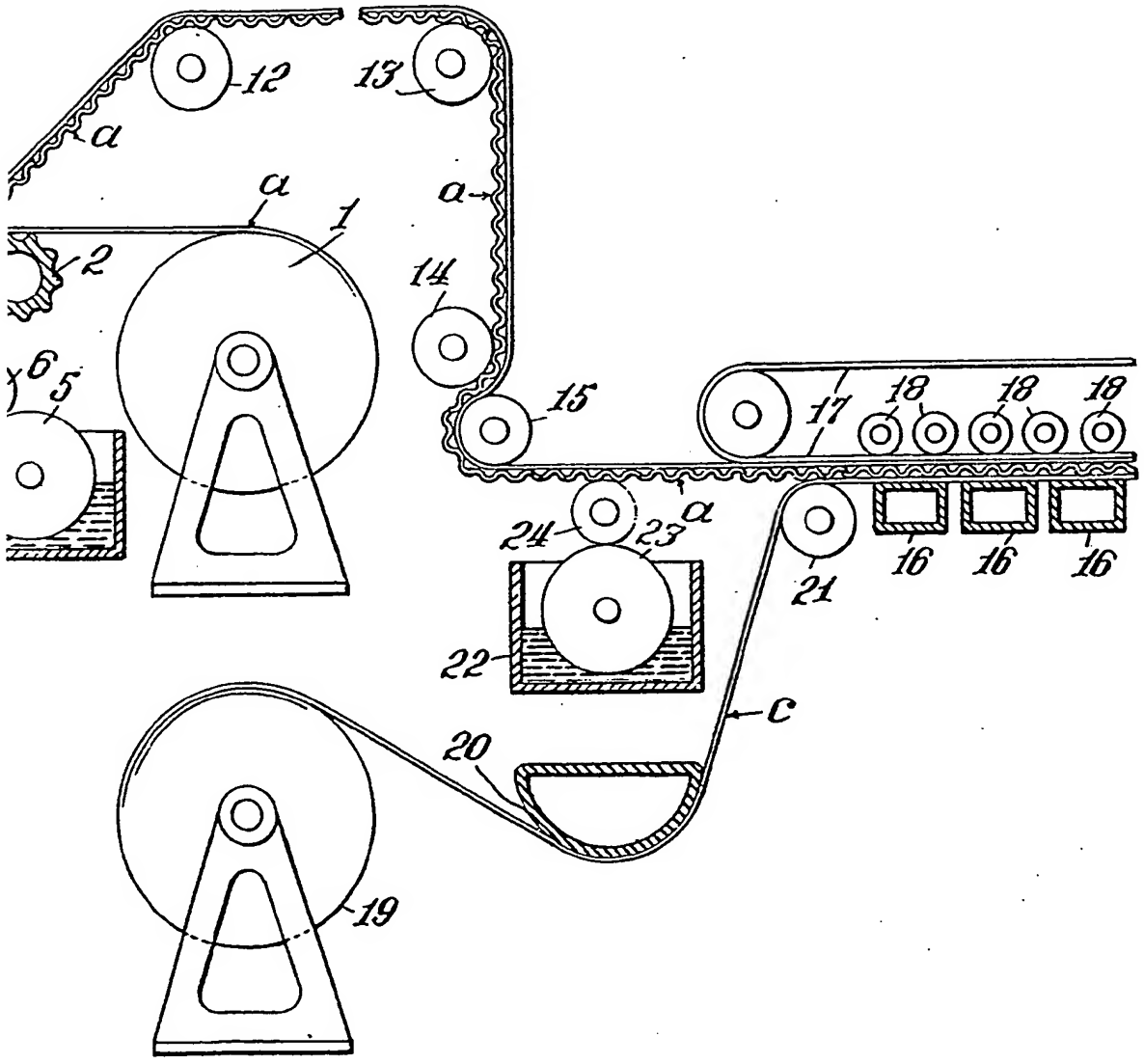

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[This Drawing is a full-size reproduction of the Original.]